Anterior Cruciate Ligament Reconstruction: 3-Incision Technique With Allograft Quad Tendon ACL Reconstruction

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Background: Anterior cruciate ligament (ACL) ruptures are becoming more common in younger and older athletes. Approximately 250,000 ACL injuries occur each year, requiring the need for an effective and reproducible surgical technique.

Indications: The 3-incision outside-in technique utilizes the donor quadriceps tendon, an extraordinarily strong graft, without damage from autogenous harvesting of patellar tendon or hamstrings. While some data suggest higher re-rupture risk with donor tissue, this is counterbalanced by avoiding secondary surgical site damage.

Technique Description: The ruptured ACL is removed and the intercondylar notch is cleaned to visualize the anatomical ACL insertion site. Using the 3-tunnel technique a gaff is passed through the intercondylar notch, through a puncture hole (incision 1) and a rear entry guide hooked to its tip. The guide point is pulled into the knee and placed in posterior aspect of the anatomic footprint of the native ACL. Through incision 2, a guide pin is drilled to this point and overdrilled with a 10-mm drill. The edges of the hole in the intercodylar notch are smoothed with a currette. The tibial footprint is cleared, a tibial aiming guide placed. Through incision 3, a guide pin is placed and over drilled with a 10-mm drill followed by a Gore-Tex reamer to ensure no impingement would inhibit graft passage. The proximal bone of a quadriceps tendon graft is sized through a 10-mm sizer and compacted. Two holes are drilled to hold sutures for the proximal aspect of the femoral graft. The quadriceps tendon graft is sized to fit through a 9-mm tunnel and the free end whipped with a stitch before being passed from outside-in through the smoothed tunnels. The femoral bone block is tapped to have a press fit initially and then is fixed with a Milagro screw. The knee is cycled ten times to remove slack and the interference fit guide pin is placed on the anterior aspect of the graft, and fixed with the knee at 15° to 30° of flexion. Stability is tested with confirmation of no impingement, and then an extra-articular reconstruction with a semitendinosus allograft is performed. The extra articular reconstruction is placed at the point between Gerdy's tubercle and the fibular head, passed under the skin and the iliotibial band, and then inserted just anterior and superior to the ACL femoral drill hole.

Results: Patient outcomes in our initial experience are comparable to our autogenous bone-tendon-bone (BTB) procedures without anterior knee pain. Return to sport is similar with autogenous procedures, with a delay of 6 to 12 months. In addition, there is a possibility for acceleration of healing with the addition of platelet-rich plasma and hyaluronic acid between 1 and 3 months postsurgery. We have insufficient data so far to determine if the re-rupture rate will decline compared with reported outcomes.

Conclusion: The 3-incision technique with allograft quadriceps tendon for ACL reconstruction is a reproducible surgical technique that avoids harvest from the patient's own body.

Patient Consent Disclosure Statement: The author(s) attests that consent has been obtained from any patient(s) appearing in this publication. If the individual may be identifiable, the author(s) has included a statement of release or other written form of approval from the patient(s) with this submission for publication.

Keywords: arthroscopy; ACL reconstruction; 3-incision technique; allograft; quadriceps tendon

VIDEO TRANSCRIPT

Anterior cruciate ligament (ACL) reconstruction at the Stone Clinic: 3-incision technique with allograft quad tendon. No disclosures. This presentation will review the background, a case presentation, imaging, preoperative planning, positioning, surgical technique, postoperative management, return to sport guidelines, and patient outcomes. ACL rupture is common with 250,000 injuries per year.[1,5] Our 3-incision outside-in technique is reproducible in all settings, including revisions, which is why we have

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stuck with it over 30 years. Donor tissue risk of re-rupture may be higher for allograft tissue in youth, but this is counterbalanced by avoiding the secondary surgical site damage.[3,4] Quadriceps tendon is significantly thicker and stronger than any of the other allograft tissues available and has bone on one end. And we always now augment ACL reconstructions with lateral extra-articular reconstruction as it reduces the revision and failure rate, especially when we're performing a revision case.[2]

We'll present the case of a 34-year-old female with persistent pain buckling and instability of her knee, who had undergone 3 previous ACL reconstructions at an outside center with her failures usually due to trauma. Her magnetic resonance imaging (MRI) is notable for derangement of her articular cartilage, rupture of her ACL and missing volume of the medial meniscus. Her preoperative physical examination was notable for laxity with a positive anterior drawer and Lachman's test, rotational instability of the 2 + medial opening and 2 + lateral opening, and a positive pivot shift. Her preoperative MRI documented her previously placed and now unstable ACL reconstruction. Here is her postoperative MRI from the procedure we're about to present. Preoperative planning: we obtain quadriceps tendon allograft, a semitendinosus allograft for use for a lateral reconstruction, a medial meniscus allograft to replace her missing medial meniscus, and we plan for articular cartilage repair. If at the time of surgery we find there is significant articular cartilage damage, we use our articular cartilage paste graft technique. The patient's position is supine on the table with a full circumferential leg holder so that we may open the joint in each plane, which especially helps for the meniscus transplantation procedure. The knee is flexed over the operating room table. Here is the procedure.

Combined knee reconstruction is best done in our hands using a full circumferential leg holder, originally designed by Lanny Johnson, which permits the surgeon to open the corners of the knee in various angles. Here is an ACL reconstruction, which left the patient unfortunately unstable. The frayed unstable ligament is probed. It is noted that this early notch arthritic spurs is removed, and the notch cleaned to be able to identify the anatomic insertion site for the ACL. It is important to note that in a previously reconstructed ACL, seeing all the way to the back of the intercondylar notch is critical. We use an outside-in technique that I call a 3-tunnel technique. As I pass a gaff to the outside of the knee, make a small puncture hole at the tip of the gaff (first incision), I load a classic ACL guide onto the tip of the gaff and bring it to the anatomic insertion site of the ACL inside the knee. One can use a microfracture awl before placing the guide to create a stabilizing spot.

A lateral incision is made (second incision) and, for a revision reconstruction, we make this incision a little bit larger than normal as often there is hardware in place. We pin the guide against the lateral femur, drive a drill pin to the tip of the guide. It is very important at this state to check the pin position from the medial portal as sometimes the intercondylar notch is deeper than one expects and there is more bone posteriorly. Once we are happy with the position, we protect the drill pin tip with a curette, over drill from outside-in with a 10-mm drill directly onto the curette. Here you can see that the entirety of the graft will be posterior to the anatomic ridge. Here, a suture is pulled through the knee. The tibial footprint is cleared to identify the anatomic footprint and be sure that there's a clear path for graft passage. A triangular guide is placed. Due to the parallax from the scope, it is important to place the guide slightly more to the medial side of the notch. A third incision is made and a drill pin is passed from outside the tibia to inside then over drilled with a 10-mm drill. Sometimes due to previous surgery, the drill pin will deflect into a non-ideal position. When that's the case, a parallel drill guide can be used to optimize the drill position. We take care to ensure that there's no impingement. Drill pin is over drilled with a 10-mm drill.

The suture is passed down the cleared tunnels and then a Gore-Tex rasp used to smooth the tunnels. In a combination ACL revision reconstruction and medial meniscus allograft, we place the ACL tunnel first and then turn our attention to the medial meniscus. Preferred donor graft is a quadriceps tendon or bone patellar bone donor tissue. We size the proximal bone through a 10-mm sizer. We compact the bone and drill 2 holes in the proximal bone to hold two Ethibond sutures. The quadriceps tendon graft is then sized to fit through a 9-mm tunnel. The fastest way to do this is to use a 9-mm parallel knife blade, which cuts the graft to the desired width.

However, the quadriceps tendon graft is quite thick and additional trimming with the scissors is often required in order for it to fit through a 9-mm sizer. The graft is trimmed to ensure that it passes smoothly through a 9-mm sizer and further compacted to make the procedure reproducible. It is important to test the entire length of the graft prior to placing it in the knee to avoid impingement. The graft is then whipped at approximately 50 mm from the bone-end to the end of the graft so that when passing the graft, there are sutures to use to augment fixation distally if required. We use a Roman sandle weave freehand tie, which we found to be just as fast and inexpensive compared with other graft weaving techniques. We augment the distal graft weave with a suture tape in case there is a need to back up the graft fixation distally. Here, we double check to be sure the graft passes smoothly through 9-mm tunnels.

The ACL quadriceps tendon allograft is then passed from outside-in after the meniscus transplantation has been placed. The ACL quadriceps tendon graft is then passed from outside in through the previously smoothed tunnels. We tap the femoral bone block to have a press fit initially on the femoral side and then fix it additionally with a Milagro screw as an interference fit screw technique, securely fixing the femoral bone attachment of the quadriceps tendon allograft. We cycle the knee to remove stretch from the donor tissue. We place the interference fit guide pin on the anterior aspect of the graft, and then fix it with the knee at 15° to 30° of flexion. We then test the stability of the knee.

We test to be sure that there is no impingement by extending the knee fully. We visualize from the anterior

medial and anterior lateral portals. Extra-articular reconstruction has been shown to dramatically reduce the risk of ACL failure in professional athletes. In view of this, we use a semitendinosus allograft. We pass a Beath pin halfway between the fibular head and Gerdy's tubercle. We over drill this with a 6-mm drill and pass the graft into the tunnel, fixing it with an interference fit resorbable screw. We then pass the graft underneath the iliotibial band with a curved passer on top of the lateral collateral ligament. We then pass another Beath pin, anterior, slightly superior to the ACL tunnel to avoid impinging on the ACL tunnel. Tunnel is drilled with a 6-mm drill. Excess length of the graft is trimmed by passing a second whip stitch along the graft and then cutting off excess graft length. The graft is then passed into this socket. Graft is passed across and then fixed with a knee and neutral position at 30°. If desired, excess length of the quadriceps tendon allograft can be further secured with suture and suture anchor at the anterior tibia in revision cases.

Patients are weightbearing as tolerated with use of crutches as necessary. We avoid direct palpation of the scar at physical therapy for the first month but do focus on soft tissue massage and inflammation reduction combined with range of motion exercises. The patients avoid high impact or cutting activities. Patients are tested for fitness at 3 months, 6 months, 1 year, and every year thereafter when they come back for fitness testing. We always try to find the weak areas in each individual and strengthen them. We avoid resisted extension machines or hamstring curl machines, never doing wall squats or wall sits as stationary exercise is not reflective of what athletes do in the field. Time tables and recommendations, of course, are modified for each athlete. Rehabilitation protocol is presented for each week and laid out in detail. The patient outcomes in our initial experience are comparable to our autogenous BTB procedures without the anterior knee pain. The return to sport is similar to autogenous procedures with a delay of twisting sports for 6 to 12 months. There is a possible acceleration of healing with the addition of platelet-rich plasma and hyaluronic acid at 1-3 months, though it is difficult to measure this and we have insufficient data so far to determine if the re-rupture rate will decline compared with reported outcomes. We acknowledge the team at the Stone Research Foundation for their excellent work in following these patients over many years and at The Stone Clinic for the clinical care given and to Greg Ondera who has helped us with the video presentations of our techniques.

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